THE

USE

OF THE

Mathematical Inſtrument,

Called a

QUADRANT:

With which plainly and eaſily to know
the exact Height and Diſtance of any
Steeple, Tree, or Houſe, *&c.*

Alſo to know the Hour of the Day by it;
the Height of the *Sun*, *Moon*, or *Stars*; and to
know the Time of the Sun-riſing and Setting;
and the Length of every Day in the Year: The
Place of the Sun in the Ecliptick, the Azimuth,
Right Aſcenſion, and Declination of the Sun;
with many other neceſſary and delightful
Concluſions. Perform'd very readily.

As alſo the Uſe of a *Nocturnal*; whereby you
may learn to know the Stars in Heaven, and the Hour
of the Night by them. With many other delightful
OPERATIONS.

The SEVENTH EDITION, wherein the Miſtakes
in the former are Corrected.

LONDON, Printed for DAN. MIDWINTER at the
Three Crowns in *St. Paul's Church-yard.* 1717.

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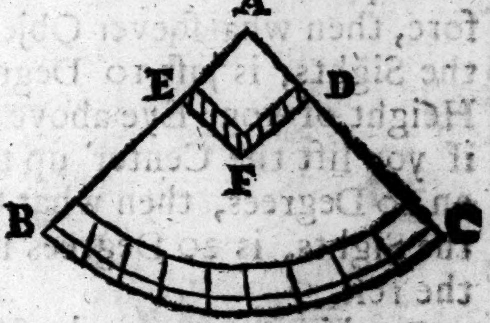
The USE of the
QUADRANT.

A *Quadrant* is the fourth Part of a Circle, and is comprehended between two Semidiameters; as in the Figure ABC, where A is the Center, AB one of the Semidiameters, and AC the other, and the outmoſt Verge BC is the Limb of the Quadrant; or more properly the Quadrant it ſelf, being one quarter of a Circle, and therefore is call'd by the Latin Word *Quadrant*.



The Quadrant BC is divided into 90 equal Parts, call'd *Degrees:* For becauſe the whole Circle contains 360 Degrees, therefore the Quadrant (which is the fourth part) muſt contain 90 Degrees; each of theſe Degrees are divided into half, or quarter, or more (as the largeneſs of the Inſtrument will admit)

being

being number'd at every tenth Degree, as 10, 20, 30, 40, *&c.*

Now foraſmuch as 90 Degrees is the higheſt Elevation, or loweſt Depreſſion of any thing, therefore very aptly doth this Inſtrument ſerve for *Menſuration*: As for Example,

If you hold the Limb of the Quadrant toward you, and the uppermoſt Semidiameter of the Quadrant parallel with the Earth or Water, then what Object ſoever you behold thro the Sights, is juſt ſo high above the Earth as your Eye is. If you lift the Center until the Thread fall upon 10 Degrees in your Quadrant, and then look thro the Sight as before, then whatſoever Object you behold thro the Sights, is juſt 10 Degrees high, and the Height of your Eye above the Ground: Alſo if you lift the Center up till the Thread fall on 20 Degrees, then what Object you ſee thro the Sights, is 20 Degrees high; and ſo of all the reſt.

By this you may underſtand what the Quadrant is made for, and what it repreſents; and tho it may be employ'd for many other things, as the taking of Angles at any Diſtance, yet the general Uſe is in what is aforeſaid. Now therefore I will ſpeak ſomewhat of the exact way to uſe the Quadrant, and to avoid Error in the uſe of it.

Take the Quadrant in your Hand, and hold it ſo that the Thread to which the Plummet is fixed, may hang down cloſe by the face or flat of the Quadrant; and be ſure that the Thread do not lean upon the Limb, or that it do not hang too far from it, but that it even touch it: then in its Poſture bring the Quadrant to your Eye, and look thro both the Sights, till you ſee the Sun, Star, or other Object which you would obſerve; then holding the Quadrant ſteddy, ſtill looking upon the Sun, Star, or other Object, lay your Finger upon the Thread, and ſo many Degrees as you find between the Thread upon the Limb, and the end of the Limb from the Semidiameter upon which the Sights are plac'd, ſo many Degrees is the Sun diſtant from your Zenith; and ſo many Degrees as is between the Thread and the other end of the Limb, ſo many Degrees is the height of the Sun or Star you obſerve above the Horizon.

Example. Looking thro the Sights to the Sun, I find the Thread to fall upon 45 Degrees of the Quadrant; therefore, I ſay, the Sun is juſt 45 Degrees above the Horizon, and 45 Degrees from the Zenith.

Again, looking thro the Sights upon a certain Star, I find the Thread to fall upon 39 Degrees and a half; therefore, I ſay, that that Star is 39 Degrees and a half above the Horizon, and 50 Degrees and a half from the Zenith.

To take the Altitude of the Sun without looking thro the Holes.

LET the Sun ſhine thro the firſt Sight next the Center, and bring that Beam of the Sun to fall right upon the Hole of the other Sight, and it will be as well or better than if you had obſerv'd it with your Eye; and then the Thread will fall upon the true Altitude of the Sun above the Horizon.

What is meant by Altitude.

THE Altitude of the Sun, Moon, or Stars, is not ſo many Miles, Poles, Rods, *&c.* as is between the Eye and the Sun, Moon, or Star; but it is ſo many Degrees and Minutes as is between the Sun or Star, and the Horizon, and therefore 'tis ſaid to be ſo far above the Horizon. I take Mr. *Norwood*'s Experiment for the beſt, who ſaith, that a Degree in the Heaven contains *69 Engliſh* Miles, or thereabout: ſo that this is true, that if I take the Altitude of the Sun at any time, and find 53 Degrees from my Zenith, I ſay that there is 53 times *69* Miles between the Place where I am, and the Place in whoſe Zenith the Sun was at that time: and by this means you may know how far it is to any Place over which the Sun or Stars are at any time.

Now in ſome Quadrants there is deſcrib'd a *Quadrat*, which is made of two Lines coming from the Semidiameter AB and AC, as in the Figure you ſee mark'd; and they are divided into 50 equal Parts. That Part of the Quadrat which is next the Sight, is call'd *The Scale of contrary Shadow*; and the other, *The Scale of right Shadow.* The uſe of the *Quadrat* is to take the Heights and Diſtances without meaſuring them.

The beſt and moſt eaſy way for the taking Heights and Diſtances, is by the *Rule of Proportion*, becauſe then any Station taken will do the Work. But becauſe ſome are not ſeen in Arithmetick, I will firſt ſhew how to take Heights and Diſtances without the *Rule of Proportion.*

Mark the Place whoſe Height you would know, and look thro the Sights to the Place, and go backwards or forward until the Thread fall juſt between the Line of right and contrary Shadow upon the Quadrat, which is upon 45 Degrees of the Quadrant; or elſe juſt upon one half of the Parts of right or contrary Shadow, or juſt upon one quarter of right or contrary Shadow: then looking thro the Sights towards the Center, obſerve till you find the Thread fall juſt between right and contrary Shadow, then is the Height equal to the Diſtance; but if it fall upon one half of the Parts of right Shadow, then is the Height but half the Diſtance; if it fall upon one quarter of right Shadow, then is the Height but a quarter of the Diſtance; if it falls on three quarters of the right Shadow, then is the Height three quarters of the Diſtance.

Now of the Parts of contrary Shadow: If the Thread fall upon half the Parts of contrary Shadow, then is the Height double to the Diſtance; if half way between this and the Semidiameter wherein the Sights are plac'd, then is the Height four times as much as the Diſtance. Now according as the Quadrat is divided, you may find hereby the way to work the Queſtion.

I will give you an Example of theſe, by which they may be the better underſtood.

I take a Quadrant that hath a Quadrat, the Parts of whoſe right Shadow are divided into fifty Parts, and the contrary Shadow into fifty Parts, and I would know the Height of a Steeple; then looking thro the Sights to the top of it, I find the Thread to fall between right and contrary Shadow: then I meaſure from the Place where I ſtood, and find it to be 25 yards and a half between that and the foot of the Steeple; to which adding the Height of my Eye from the Ground, being a yard and a half, it makes 27 yards, the juſt Height of the Steeple; for you muſt always remember to add the Height of your Eye from the Ground.

Again, looking to the top of the Steeple, the Thread falls upon 25 yards of right Shadow; and meaſuring, I find 51 yards between me and the foot of the Steeple; the half whereof is 25 yards and a half, to which adding one yard and a half for the height of my Eye, makes 27 yards, the Height of the Steeple.

Now taking another Station, I find when I look to the top of the Steeple, that the Thread falls upon twelve Parts and a half of right Shadow; and the Diſtance I find to be 102 yards, one quarter of which is 25 yards and a half, and one yard and a half makes 27 yards, the Height of the Steeple.

Now for the Parts of the contrary Shadow, looking to the top of the Steeple, I find 25 Parts of contrary Shadow cut by the Thread, and the Diſtance between me and the foot of the Steeple I find to be 12 yards and a half; which being doubled, make 25 yards; and one yard and an half, the Height of my Eye, makes 26 yards and a half, the Height of the Steeple.

Again, I look thro the Sights to the top of the Steeple, and find 12 Parts and a half of contrary Shadow cut by the Thread; and meaſuring from my foot to the foot of the Steeple, I find it 6 yards and 13 inches; which doubling 4 times, it makes it 25 yards and a half; and one yard and a half added to it, is 26 yards, the Height of the Steeple.

Now if ſtanding upon a known Height, you would know a Diſtance, work as you did before; only that which was then the Parts of right, muſt now be the Parts of contrary Shadow; and that which was then the Parts of contrary Shadow, muſt now be the Parts of right Shadow.

I will give you but two Examples of this, and let the Reader ſtudy the reſt by this.

(1.) Standing upon a Steeple 27 yards high, let the Quadrant be lifted no higher than is the Steeple; if you do, you muſt allow ſo much as it is higher; I look to the Root of a Tree, and find the Thread to cut 25 Parts of that which now is contrary Shadow: therefore doubling the Height of the Steeple, which is 27 yards, you have 54 yards for the Diſtance between the foot of the Steeple and the root of the Tree.

(2.) Looking to the bottom of a Houſe-wall, I find the Thread fall upon 25 Parts of that which is now right Shadow; then is the Diſtance between the foot of the Steeple and the bottom of that Wall but half the Height of the Steeple, which half will come to be 13 yards and a half.

But if looking to a Place, the Thread fall juſt between right and contrary Shadow, then is the Diſtance and Height equal.

In the taking of Diſtance upon a Height, you muſt do contrary to what you did before; for there you look'd firſt thro the Sight furtheſt from the Center, but now you muſt look thro the Sight next the Center firſt, and then thro the next to the Place you obſerve: And Note, that by Heights we ſpeak only of perpendicular or upright Heights, and in Diſtances only of Levels.

Now follows the Uſe of the Quadrat by Arithmetical Operations.

Firſt for the taking of Heights: Take any Station, and look to the top of the Wall-houſe, Window, Steeple, or Tree, whoſe Height you would know, but get your Station as near it as may be: then mark whether the Thread fall upon the part of right or contrary Shadow; if it fall upon right Shadow, then as all the Parts of right Shadow are to the Parts between the Thread and the Semidiameter, ſo is the Diſtance to the Height.

But if the Thread fall upon the Parts of contrary Shadow, then, as the Parts between the Thread and the Semidiameter are to all the Parts of contrary Shadow, ſo is the Diſtance to the Height: and of the contrary of theſe two it holds good; that is, that as in right Shadow as the whole of the Parts is to the Parts cut by the Thread, ſo the Diſtance is to the Height: So on the contrary, as the Parts between the Thread and the Semidiameter are to all the Parts of right Shadow, ſo is the Height to the Diſtance, and in the Parts of contrary Shadow it holds true.

That as all the Parts of contrary Shadow are to the Parts between the Thread and the *Radius*, ſo is the Height to the Diſtance: So that obſerving this for a general Rule, it is eaſy to find any Height or Diſtance. I will give two or three Examples in both theſe Caſes, and firſt of right Shadow.

I take a Quadrant, whoſe Quadrat hath each ſide divided in 50 Parts, and looking to the top of a Steeple, I find the Thread to fall upon the 7 Parts of right Shadow, and I meaſure to the foot of the Steeple, and find it to be 520 yards; then I ſay,

As 50 the whole of the Parts of right Shadow is to 7, the Parts between the Thread and Semidiameter, ſo is 520 the Diſtance given to 72 yards, 3 foot, 4 inches, the Height requir'd.

Example. I look to the top of a Tree thro the Sights, and find the Thread to fall upon 44 Parts of right Shadow, and from my foot to the foot of the Tree five yards; then I ſay,

As 50 the whole Parts of the Shadow is to 44 the Parts cut by the Thread; ſo is 5 yards the Diſtance meaſur'd, to 4 yards, 1 foot, and 2 inches, the Height requir'd.

Now for the taking of a Diſtance, being upon a known Height.

Example. Standing in a Window, ſo that between my Eye and the Ground are 9 yards, and looking to the foot of a Tree or Houſe, I find the Thread to fall upon 25 Parts of right Shadow ; then for the Diſtance between the foot of the Tree and the foot of the Houſe, I ſay,

(1.) As 25 the Parts whereon the Thread falls, is to 50 all the Parts of the right Shadow, ſo is 9 yards the Height given, to 18 yards the Diſtance requir'd. And always when you ſtand upon a Height to take a Diſtance, you muſt look thro that Sight next the Center firſt.

(2.) For the Parts of contrary Shadow: Looking to the top of a Houſe, I find the Thread to fall upon 17 Parts of contrary Shadow, and the Diſtance between me and the Houſe I find to be 6 yards; then I ſay by proportion,

As 17 the Parts on which the Thread falls, is to 50 all the Parts of the Shadow ; ſo is 6 yards the Diſtance to 17 yards, 2 foot, the Height ſought.

Example. Standing upon a Tower 50 yards high, I ſee a Hill's foot thro the Sights, and the Thread falls upon 27 yards of contrary Shadow: Therefore I ſay,

As 50 the whole content of the Parts, is to 27 the Parts cut by the Thread, ſo is 50 yards the Height, to 27 yards the Diſtance of the Place I ſaw. And ſo you may do it in any Caſe, obſerving well the general Rule laid down before.

It reſteth that I ſpeak a little of knowing how to find a Height or a Diſtance at two Stations, meaſuring only the Diſtance between them, for ſometimes you cannot meaſure the Diſtance to the Wall, by reaſon of ſome hindrance.

For the ſolution of this, do thus: Work as is before ſaid; only whereas then you had either the Height or Diſtance given, now you muſt give a gueſs at the Height or Diſtance; and having ſuppos'd the Diſtance to be ſo much, I have before ſhew'd how to find the Height, and alſo, having the Height ſuppoſed, to find the Diſtance. This is laid down before, either when the Thread falls upon the Parts of right or contrary Shadow.

Then having taken the Height or Diſtance by ſuppoſition, take another ſtanding, and make your ſecond Obſervation; and taking the firſt ſuppoſed Height for granted, find out your Diſtance, as is taught before: having ſo done, you have theſe four things given, *viz.*

1. The ſuppoſed Height.

2. The ſuppos'd Diſtance from the firſt Station to the thing you obſerve.

3. The Diſtance from the ſecond Station: and by that,

4. The Diſtances of the two Stations one from another: all this is ſuppos'd. Now meaſuring between the firſt and ſecond Stations, I find my Error; therefore all the Errors being proportional, I ſay thus.

As the ſuppos'd Diſtance between the two Stations is to the true Diſtance between them, ſo is the ſuppoſed Height to the true Height: and as the ſuppos'd Diſtance is to the true Diſtance of the Stations, ſo is the ſuppos'd Diſtance of either Stations from the thing obſerv'd, to the true Diſtance of either Station.

Thus you may take the Height of a Mountain, or of a Houſe, Tree, or any thing, and the true Diſtance between you and the Place under the Height you obſerve.

Now I will give Examples of this, and ſo conclude with the Quadrat.

I would know the Height of a Steeple, therefore taking one Station, I find the Thread fall on 35 Parts of right Shadow; and becauſe I cannot meaſure to the Steeple, becauſe of the Unevenneſs of the Ground, or ſome other Impediment, therefore I ſuppoſe the Diſtance 40 yards: Then I ſay,

As 50 the whole Parts of the Shadow is to 35 Parts cut by the Thread, ſo is 40 yards ſuppos'd Diſtance, to 28 yards the ſuppos'd Height.

Then going a little farther in a ſtrait Line, ſo that my firſt Station lie between my ſecond Station and the Steeple, I find the Thread to fall upon 33 Parts of right Shadow: Then I ſay,

As 33 Parts cut by the Thread, is to 50 the whole Parts of the Shadow; ſo is 28 the ſuppos'd pos'd Height to 42 yards, 1 foot, 3 inches, the ſuppos'd Diſtance of the ſecond Station: So that the ſecond Station is diſtant from the firſt Station, by ſuppoſition, 2 yards, 1 foot, 3 inches. Now if meaſuring theſe Diſtances, I find it to be but 2 yards, 3 inches; then I ſay,

As 2 yards, 1 foot, 3 inches, the ſuppos'd Diſtance of the ſecond Station, is to 2 yards 3 inches their true Diſtance; ſo is 28 yards the ſuppos'd Height, to 24 yards, 4 inches, the true Height.

Then for the Diſtance, I ſay,

As 28 yards the ſuppos'd Height is to 24 yards, 4 inches, the true Height; ſo is 24 yards, 1 foot, 3 inches, the Diſtance of the ſecond Station, to 36 yards, 1 foot, 7 inches, the true Diſtance of the ſecond Station.

Then for the Diſtance of the firſt Station: Take away their difference 2 yards, 1 foot, 5 inches, and the remainder will be the Diſtance of the firſt Stations.

Thus you may do when it falls upon the Parts of right Shadow; but if the Thread falls upon the Parts of contrary Shadow, then do, as by this Example following.

Looking thro the Sights to the top of a Hill, I find the Thread to fall upon the 20 Parts of contrary Shadow; then ſuppoſe the Height to be 14 yards, I ſay, As 50, all the Parts of the Shadow, is to 20, the Parts cut by the Thread; ſo is 84 yards the ſuppos'd Height to 33 yards 2 foot, the ſuppos'd Diſtance of the firſt Station.

Then going farther off, I make Obſervation, and find the Thread to fall upon 22 yards of contrary Shadow: Then for the Diſtance I ſay,

As 50 the Parts of contrary Shadow are to 22 Parts cut by the Thread, ſo is 84 yards the ſuppos'd Height to 34 yards, 2 foot, 10 inches, the ſuppos'd Diſtance of the ſecond Station; ſo that the Difference by ſuppoſition between the two Stations, is 1 yard and 10 inches.

Now if I meaſure the Diſtance of the two Stations, I find them to be diſtant 3 yards: I ſay, firſt for finding the true Height,

As 1 yard 13 inches the ſuppos'd Difference of the two Stations, is to 3 yards their true Difference; ſo is 84 yards the ſuppos'd Height to 197 yards 7 inches the true Height.

Therefore for the Diſtance I ſay;

As 1 yard 10 inches, the ſuppos'd Diſtance of the Stations is to 3 yards, their true Diſtance; ſo is 3 yards the ſuppos'd Diſtance of the firſt Station to 77 yards, 1 foot, 5 inches, the true Diſtance of the ſame firſt Station: To which if you add 3 yards, you have 80 yards, 1 foot, 5 inches, the Diſtance of the laſt Station.

And in the working of this, let the Reader be very exact, (1.) In his Obſervations. (2.) In his Calculations: and then he need not doubt but his Work will come true and right.

This might have been exceedingly illuſtrated, if Prolixity had been affected; but I doubt not but by this a careful Student will accompliſh any Queſtion, either of Heights or Diſtances of Things; or in taking the Altitudes of the Sun, Moon, or Stars: And in thy reading, if any thing ſeems dubious unto thee, look forward or backward, and then thou wilt, by comparing one thing with another, find out the real Truth.

SECT. II.

Shewing the Uſe of Hour-Lines, and Azimuth-Lines, &c.

BEcauſe the Quadrat and Quadrant fill not up the Inſtrument, but there are vacant Places left without any Inſcription; therefore many ingenious Men have invented ſeveral Lines, *&c.* to fill them up with.

And firſt of all *Stophler* (in his *Elucidatio Fabrica uſuſque Aſtrolabii*) teaches to make Hour-Lines for the time of the Day; yet he deſcribes them in his Quadrant in ſuch an imperfect manner, that it is plainly to be ſeen, he rather affected Eaſe, than Truth.

Since him, Mr. *Gunter* hath invented Hour-Lines, after a more perfect way, and alſo illuſtrated the Quadrant with Azimuth-Lines, and a Scale of the Days of the Month, and Arches of the Horizon, and the Ecliptick-Line, and alſo the place of ſome notable Stars that lie between the Equator and Tropick.

Others alſo have exercis'd their Wits, in inventing ſeveral Conceits to fill the Inſtrument up with; as namely, Mr. *De le Main*, M. *Outred*, M. *Foſter*, M. *Stirup*, M. *Dayry*, &c. all different one from the other, as I ſhall hereafter ſhew in convenient place.

But firſt I ſhall ſhew you the Uſe of divers Lines, that Mr. *Gunter* hath deſcrib'd in his Quadrant; and tho they be ſufficiently and learnedly handled by himſelf in his Book, yet I think it not amiſs to make them plain and eaſy to be underſtood of ſuch as are not otherwiſe mathematically given, but only deſire to know the uſe of the Quadrant, *&c.*

And therefore I ſhall begin with the Circle of Months, which you ſhall find deſcrib'd juſt within the Limb, in 4 Arches of Circles; one end of them reaching to 62 Degrees of the Quadrant, and the other to 15 Degrees of the Quadrant.

The two next the Quadrant, or Limb, are from the 10th of *June* to the 11th of *December*, all which time the Days ſhorten to us, who live under the North Hemiſphere;

and in the ſame time the Sun goeth from the beginning of ♋ to the beginning of ♑. The other 2 Circles do contain the other half of the Year, that is, from the 11th of *December* to the 10th of *June*; each Month, at the beginning of it, is noted with the firſt Letter of that Month; as J, F, M, A, M, J, J, A, S, O, N, D; that is, *Jan. Feb. March*, &c.

(1.) Each of theſe Months is divided into every fifth day, or every particular day, as the Largeneſs of the Inſtrument will bear it, by a ſmall Stroke drawn croſs the two Circles; and thoſe Strokes that extend themſelves on the one ſide to the Limb, and on the other ſide to the Circle next above them, note the beginning of a Month; and at that Stroke is ſet the Letter that notes the Month that begins.

(2.) Next to this Circle of Months towards the Center, where the Thread is faſtned, is a Circle (or rather an Arch of a Circle) drawn from one Semidiameter to the other; and this is call'd the Tropick, and ſerveth in its uſe both for the Tropick of ♋ and ♑: At one end you may find this Arithmetical Figure 8, and at the other end theſe two Characters of ♋ and ♑.

(3.) That Circle which you ſee part of is cover'd by the Quadrat, and hath theſe Figures upon it, 6, 7, 8, 9, 10, 11, 12, 30, 60, 90, is the Equator or Equinoctial: It is drawn from one Semidiameter to the other, and is neareſt the Center of any other of the Circles.

(4.) That three-lin'd Circle which is drawn from the Figure 6 in the Equator, to the end of the Tropick, and is divided into three times 30 Diviſions, is the Ecliptick; and upon it are put the Characters of the twelve Signs of the Zodiack, thus, ♈♎♍♓♉♏♌♒♊♐♋♑; but you muſt read them in due order, as ſhall be ſhew'd hereafter.

(5.) From 6 in the Equator, to the latter end of ***February*** in the Circle of Months, is drawn an Arch of a two-lin'd Circle, and is divided into Parts as the Ecliptick is; and is numbred from the Equator to the Tropick: This is call'd the Horizon.

(6.) From the Equator to the Tropick upon the Semidiameter, is a Diviſion of 23 equal Parts, and one half of a Part, numbred 10 and 20: This is call'd the Line of Declination.

(7.) From 7, 8, 9, 10, 11, 12, in the Equator, are drawn ſix Lines, bending towards the Line of Declination: and again, from 22 and 12 Parts in the Line of Declination; and ſo from 6, 7, 8, 9, 10, 11, 12, in the Equator, and bending from the Line of Declination, and are 9 in number: Theſe croſſing the other that bend towards the Line of Declination, are all of them call'd the Hour-Lines. And here note, That the Hour-Line which is drawn from 12 in the Equator, to the Tropick juſt over *June* in the Circle of Months, is the Bound of the Hour-Lines. Between every two Hour-Lines are drawn Touches of Lines thus---- for the half Hour-Lines, and between every half and whole Hour-Line is drawn prickt Lines thus...... for the quarter Hour-Lines.

(8.) All thoſe Circles drawn on the other ſide, of which I have ſaid nothing yet, are the Azimuths, and are numbred by tens, with 10, 20, 30, 40, 50, 60, 70, 80, 90, in the Equator; and with 100, 110, 120, upon the Semidiameter; and between every tenth Azimuth, are drawn Touches of Lines thus ------repreſenting every fifth Degree of Azimuth. The number of them drawn bending towards the Line of Declination, is 26; and thoſe drawn bending the other way, are 18 in number.

(9.) Ye may ſee *Peg. Wing*, or *Pegaſus Wing*, and *Arctus*, or *Arcturus*: and *Cor* ♌ or the *Lion's Heart*, and the *Bull's-Eye*, and the *Vulture's-Heart*, each having plac'd by them a Star thus *, which are the Names of 5 Stars, which are all between the Equator in the Heavens, and the Tropick of ♋; and to each Star is ſet down the day of the Month and Hour that it comes to the South.

(10.) The Sights, which are two Pieces of Braſs, with two little Holes in them to look thro, or to let the Sun ſhine thorow; and theſe Sights are plac'd upon one of the Semidiameters.

Laſtly, The Center, where the Thread is faſtned; beſides this, it muſt have a Plummet and a Bead upon the Thread.

Note, That this is the Deſcription of a large Quadrant, engraven and printed by Mr. *Moxon*, and by him very accurately paſted on a Board, and fitted up with Sights, and a Bead, *&c.*

The Uſe of the Circle of Months, Ecliptick, Horizon, Line of Declination, Hour-Lines, Azimuths, and the five Stars, are briefly as followeth.

Firſt, *The Uſe of the Circle of Months.*

TO find any Day of the Year requir'd, firſt look out the Month; and then from the beginning of it count at the firſt croſs Stroke five days (unleſs the Months be divided into particular days) and the next Stroke five more, that is ten days; till you come at the day you look for.

Example. (1.) I would find the 17th day of *November*; then having found *N* for *November*, I count towards *December*, that is, towards *D*, and ſay 5, 10, 15, 20, therefore between 15 and 20 muſt be 17; ſo I gueſs at the 17th day, and lay the Thread upon it, and find it to fall upon 17 Degrees and an half in the Limb. Now in *June* or *December* 'tis hard to find the day of the Month, or to 7 or 8 days, but all the reſt of the Year is eaſy enough.

(2.) Having found the day of the Month, to find how high the Sun will be at Noon.

Lay the Thread upon the day of the Month, and the Degree cut by the Thread in the Limb is the Meridian Altitude, or the Height of the Sun at Noon; ſo the Height of the Sun upon the 18th day of *March*, you will find to be 41 Degrees, 45 Minutes.

(3.) To find what Days of the Year are of equal Length.

Lay the Thread upon the Day given, and on the other ſide it will fall upon the Day equal in length to that.

Example. I deſire to know what day is juſt as long (or as ſhort) as the 18th day of *March*; I lay the Thread to the 18th of *March*, and on the other ſide it falls upon the 5th day of *September*; ſo that thoſe two days are both of a length, and the height of the Sun at Noon upon either of them is 41 Degrees, 45 Minutes.

Note, That the height of the Sun at Noon here given, is true only at the renowned City of *London*, or at any place that lieth due Eaſt or Weſt from it; but in any Place that is 70 Miles more North than Eaſt or Weſt of *London*, to them the Sun will be a Degree lower than by the Quadrant (fitted for *London*) will appear; but if you be 70 Miles South of *London*, than will the Sun be a Degree higher than the Quadrant will ſhew: and ſo allowing 70 Miles for a Degree, you may make the Quadrant univerſal in this thing.

(4.) If you have the Height of the Sun at Noon, you may find the Day of the Month; but this is difficult to do it truly.

Secondly, *The Uſe of the Ecliptick Circle.*

THis Circle, as is before ſaid, is drawn from 6 in the Equator, to the other ſide of the Tropick, and is divided into each ſingle Degree; and at the beginning of each Sign is a long Stroke, and at every tenth Degree a Stroke a little ſhorter, and each fifth Degree with a ſhorter Stroke. Now upon this Arch are the Characters of the 12 Signs, which you muſt note follow one another in this Order, ♈ ♉ ♊ ♋ ♌ ♍ ♎ ♏ ♐ ♑ ♒ ♓, and the twelve Signs anſwer to the twelve Months of the Year, and do proceed on in order.

And here is to be noted, that the Sun enters ♈ upon the 10th of *March*, and ♉ the 10th of *April*, and ſo of the reſt: ſo that in *February* the Sun will be found to be in ♓. Now I ſhall ſhew you how to ſet your Bead for any day, which muſt be done thus:

From twelve in the Equator to the end of the Circle of Months, is drawn an Hour-Line: and from the ſame twelve in the Equator, to the other end of the Circle of Months, is drawn another Hour-Line.

That which falls upon *December*, is the Hour-Line of twelve in the Winter; and the other the Hour-Line of twelve a Clock in the Summer: Now lay the Thread upon the day of the Month,and move the Bead up or down, till it be juſt upon one of theſe two Lines, and ſo is your Bead rectify'd for that day. So upon the 18th of *March*, bring the Thread to the day of the Month, and move the Bead up or down, till it fall upon the Hour-Line of twelve in the Summer.

How to find theſe three Things following upon the 18th of March.

1. *To find the Sun's Place in the Ecliptick.*

Having rectify'd the Bead, as before, bring it to the Ecliptick, and it will fall upon the Degree the Sun is in that day: So upon the 18th of *March* I find the Sun to be in 8 Degrees of ♈; and upon the 17th of *October*, I find it to be in 3 Degrees of ♏, ♏ being the Sign anſwering to *October*. And ſo by the contrary; if you know the place of the Sun, you may find the day of the Month.

2. *To find the Sun's Declination.*

Having rectify'd the Bead, as before, bring it to the Line of Declination, and it will ſhew you the Declination of the Sun for that day: Thus upon the 17th of *October* I find the Sun to have 12 Degrees Declination; and upon the 18th of *March* it hath 3 Degrees and an half Declination. And note, That if the Bead fall upon the Winter 12 a Clock Line, then is the Declination South; but if the Bead fall upon the Summer-Line of 12 a Clock, then the Declination is North: And by the ſame way, if you have the Sun's Declination given, you may find his place in the Ecliptick, and the day of the Month.

3. *To find the right Aſcenſion of the Sun.*

Having rectify'd the Bead, bring it to the Ecliptick, and the Degrees cut by the Thread in the Limb, is the right Aſcenſion: But when the Sun hath gone three Signs from ♈, for every 3 Signs you muſt add 90 Degrees to the right Aſcenſion cut in the Limb, and then have you the right Aſcenſion. Thus upon the 18th of *March* the right Aſcenſion is 12 Degrees, and upon the firſt of *Auguſt* 126 Degrees, and upon the 10th of *October* it is 208 Degrees, and upon the 9th of *March* it is 360 Degrees.

Thirdly, *The Uſe of the Horizon-Line.*

THis Double-Line is divided in 40 Parts, and number'd with 10, 20, 30, 40. The Uſes of it are three, *viz.*

1. *To find the Sun's Amplitude, or his Riſing or Setting, from the Eaſt or Weſt Points of the Compaſs, in the Horizon of* London.

Having rectify'd the Bead, bring it to the Horizon, and it will ſhew the Amplitude. Thus upon the 9th day of *April* the Amplitude is 19 Degrees towards the North: And note, that from the 10th of *March* to the 11th of *September*, it hath North-Amplitude, but all the reſt of the Year the Amplitude is South.

2. *To find the Aſcenſional Difference.*

Rectify the Bead, and bring it to the Horizon, and the Degrees cut in the Limb ſhall be the Aſcenſional Difference: Thus the Aſcenſional Difference the 9th of *April* is 15 Degrees; and having the Aſcenſional Difference, 'tis eaſy to find the time of Sun-riſing and ſetting, and thereby the length of the Day and Night.

For the Time of Sun-riſing.

Find out the Aſcenſional Difference; then if the time be between the 10th of *March* and 11th of *September*, allow for each Degree of Aſcenſional Difference, 4 minutes of time; for ſo much doth the Sun riſe before 6 in the Summer, and after 6 in the Winter.

So upon the 9th of *April* I have 15 Degrees of Aſcenſional Difference, which is 15 times 4 minutes, that is juſt an Hour. Now becauſe 'tis in the Summer, I ſay the Sun riſeth an hour before 6 in the Morning, that is, at 5 a Clock in the Morning. And note, that ſo much as the Sun riſes before 6, ſo much it ſets after 6; and ſo much as it riſes after 6, ſo much it ſets before 6.

To find the length of the Day is eaſy; for counting the time from Sun-riſing till Noon the ſame day, I have 7 hours; and the Afternoon being always the ſame length as the Forenoon is of, gives me 7 more; which added together, make 14 hours for the length of the day; which taken from 24 hours, leaves 10 hours the length of the Night. Thus you may find the time of the Sun-riſing and ſetting, and the length of the Day and Night to a Minute of Time.

Fourthly, *The Uſe of the Hour-Lines.*

THoſe Lines that are drawn from 6, 7, 8, 9, 10, 11, 12, in the Equator, bending towards the Line of Declination, are the Hours of the Day in the Winter, and of the Night in the Summer; and they are number'd firſt in the Equator, to ſhew what Hour they do belong to; and again, they are number'd above the Tropick. The other Hour-Lines drawn bending from the Equator, are the Hours of the Day in the Summer, and of the Night in the Winter; they are number'd in the Equator, and in the Tropick: ſo that the firſt drawn from 12 in the Equator to the end of *June*, is 12 a Clock at Noon in Summer, and 12 at Night in Winter; the next is 11, or 1 a Clock after Noon in the Summer, and 11 and 1 a Clock at Night in Winter: and ſo you may find out all the reſt, as by the enſuing Particulars will more plainly appear.

Having the Height of the Sun, to find the Hour of the Day.

First rectify your Bead, then take the Altitude, and the Bead will fall upon the Hour of the Day: As for Example,

I rectify the Bead upon the 9th of *April*, and taking the Height of the Sun, I find it 31 Degrees high, and the Bead, at that Obſervation, fell juſt half way between the Lines of 8 and 9 in the Equator, and 3 and 4 at the Tropick; ſo that it is half an Hour paſt 8 in the Morning, or half an Hour paſt 3 in the Afternoon. Now if the Sun riſes higher, it is before Noon; but if it deſcend lower and lower, then 'tis Afternoon.

And ſo by the ſame way upon the 1ſt of *November* I make Obſervation, and the Bead falls half way between 1 and 9, and 3 and 4 in the Winter Circles; therefore 'tis half an Hour paſt 3 in the Afternoon, or half an Hour paſt 8 before Noon: And thus with a little Diligence you may find the Hour of the Day to a ſmall matter.

To know how high the Sun will be at any Hour.

Rectify the Bead, then bring it to the time given, and the Thread will cut ſo many Degrees in the Limb, as the Sun will be high at that time. Thus upon the 30th of *March* I find that at 8 a Clock in the Morning, the Sun is 24 Degrees and an half high, and it comes to the ſame Height at 4 in the Afternoon the ſame day.

To find how low beneath the Horizon the Sun is at any Hour in the Night.

Rectify the Bead for the preceding Day, and bring it to the Hour of the Night, and in the Limb the Thread will ſhew you how low the Sun is at any time of the Night: Thus upon the 30th of *March*, at 11 at Night, the Sun is 28 Degrees and an half low beneath our Horizon.

To find the Time of Day-break.

This is when the Sun is 18 Degrees beneath our Horizon; therefore rectify the Bead for the Day, and lay the Thread upon 18 Degrees in the Limb, and the Bead will fall upon the Hour of Day-break; ſo upon the 30th of *March* the Day will break at 3 a Clock in the Morning. And by this it is eaſy to find when it will be dark at Night; for that muſt be ſo much after 6, as this is before 5, which is 3 Hours: ſo at 9 at Night it will be dark, or paſt Twilight.

As on the left hand of the Quadrant, the Hour-Lines are drawn bending from the Equinoctial to the Tropick; ſo likewiſe on the right hand of the Quadrant are drawn ſuch other Lines, which bend alſo from the Equinoctial to the Tropick, and are call'd Azimuths, and are number'd in the Equinoctial with 10, 20, 30, *&c.* to 90, and then downwards from the Equinoctial to the Tropick with 110, 120, 130, and ſome odd Degrees of Azimuth. Now on the Quadrant I mention'd before, you have not only every tenth Azimuth-Line deſcrib'd, but alſo every fifth Azimuth-Line drawn with ſuch Touches of Lines, as the Half-Hours are mark'd with.

Fifthly, *The Uſe of the Azimuth-Lines.*

Note, THat thoſe Lines that bend towards the Line of Declination, are the Summer Azimuths; and that which is neareſt the Line of Declination, which is on the left hand, is the Meridian Line, or full South in Summer.

And all thoſe drawn the other way, are the Winter Azimuths; and that next the Line of Declination (tho bending from it towards the right hand) repreſenteth the Meridian, or full South Point of the Compaſs in the Winter. But,

To find the Point of the Compaſs wherein the Sun bears at any height, do thus:

Firſt rectify your Bead; then take the Altitude of the Sun, and obſerve well that Altitude, and ſo much as your Altitude is, count ſo many Degrees in the Limb from 90, and bring the Thred to that Degree: then will the Bead fall upon the true Azimuth.

Example. Upon the 9th of *April* I take the height of the Sun, and find it to be 25 Degrees; therefore I lay the Thred 25 Degrees from 90 Degrees, and the Bead falls upon almoſt 80 Degrees from the Meridian. Whether this 80 Degrees be from the Meridian to the Eaſtward, or to the Weſtward, I know by the time of the day; for if it be after Noon, then it is 80 Degrees to the Weſtward; but if before Noon, 80 Degrees to the Eaſtward. This is of many great Uſes, and therefore I will ſhew how to draw a Compaſs upon any place whereon the Sun ſhines, be it either upon a Wall, or on the Ground.

Firſt, With a Pair of Compaſſes deſcribe a good large Circle, the bigger the better; then when the Sun ſhines upon the Circle, ſet a ſmall Stick or Nail upright in the middle or Center of the Circle; then take the height of the Sun, and note it well; then preſently make a mark at the end of the ſhadow of the Nail or Stick; then take away the Nail, and lay a Ruler over the Center, and the mark you made at the end of the ſhadow, and ſo draw a Line from one ſide of the Circle to the other, by the ſide of the Ruler; then (as is before ſhewed) you may find how much one end of that Line is from the true South. Then having ſo many Degrees, as the Sun was from the South, lay the Center of the Quadrant upon the Center of the Circle; and from the Center of the Quadrant extend the Thred to the place of the Sun upon that Circle, and bring that degree which you know the Sun is from the Meridian under the Thred, and one end of the Limb will point at the true South, the other at the Eaſt, if it be before Noon, but to the Weſt, if it be Afternoon; then is the North oppoſite to the South, and ſo have you the true Eaſt or Weſt, North and South, of any place whatſoever which is any thing near *London*: as within 10 Miles the Error will be but ſmall; but if it be true Eaſt or Weſt from *London*, the Error will be ſcarce any thing. And thus you may find ſeveral Particulars; as how one Place lieth from another; how to deſcribe a Dial on a plain level Place; and how much the Magnetick Needle varies in any place.

Now you may divide the Circle you make into 360 Degrees, and deſcribe the 32 Points of the Compaſs, and many very rare Concluſions. And as I deſire thee to take heed of all Errors and Miſtakes, ſo eſpecially in this, that you be ſure to account your Altitude from 9, towards 10 Degrees in the Limb; for this you muſt always do in finding out the Sun's Azimuth, or Point of the Compaſs, and ſo by the contrary 'tis eaſy

To find the height of the Sun at any Azimuth, thus:

Rectify the Bead, then bring it to the Azimuth whereupon the Sun is; and ſo many Degrees in the Limb, as it is between the Thred and 90 Degrees, or the end of the Limb, ſo much is the Altitude at that time.

Laſtly, *The Uſe of the five Stars is thus:*

PUT the Bead to the Star you intend to obſerve, and find how many Hours it is diſtant from the Meridian, or 12 at Night, as you found how far the Sun was diſtant from 12 at Noon; then find the right Aſcenſion of the Sun, and alſo the right Aſcenſion of that Star; then out of the one take the other, and turn the reſt into Time, allowing 15 Degrees for an Hour, and 4 Minutes for a Degree: then that Time you found to remain after the Subſtraction, add to the Hours you find the Star from the Meridian, and they will make the time that it is ſince 12 a Clock at Noon.

The USE of the NOCTURNAL.

1. *What the* Nocturnal *is.*

IT is an Inſtrument conſiſting of two Parts. 1. A *Circle*, which is divided into 24 hours, and each hour into ſo many parts, as the ſpace between each hour will admit of.

The *Nocturnal* fitted to the backſide of that Quadrant I have already treated of, is divided into 4 Quarters, and each Quarter into 2 parts; ſo as the whole hour is divided into 8 equal parts, each equal part containing ſeven Minutes and a half, as you may ſee in the *Nocturnal* it ſelf. Upon the hour of 12 there is plac'd a *Flower-de-luce*, to ſignify the North-point; and in the utmoſt Circle, the Names of all the other Points of the Mariner's Compaſs.

The ſecond part of it is a *moveable Rundle*, the Circle whereof is fixed to the Center of the Circle of Hours, that ſo you may turn it round, as occaſion requires. The outmoſt Circle of this *Rundle* is divided into 12 parts, for the 12 Months, each Month having its Name prefix'd to it in Roman Capital

Letters, and each day in the Month diſtinguiſh'd with a ſmall Stroke, and every tenth Stroke, for the readier counting the Days, drawn longer and marked with Figures, 10, 20, *&c.* according to the number of Strokes from the beginning of the Month.

Within the Circle of Months is another Circle deſcrib'd, divided into 12 equal Parts, repreſenting the 12 Celeſtial Signs, every Sign having its name prefix'd to it in *Italian* Capital Letters; and each Sign ſubdivided into 30 Degrees, and each 10th Degree marked 10, 20, or 30, according to the number of Degrees from the beginning of the Sign.

In the reſt of the Plane within the Circle are deſcribed thoſe fixed Stars that are near the North-Pole, and belonging to ſeven Conſtellations; whereof that which is the middle is call'd *Urſa Minor* (by ſome *Helice Minor*) which is in *Engliſh* the *Little Bear*, it being in the form of a Bear.

This Conſtellation conſiſts of 7 Stars, whereof 2 only are ſplendent; that is, the *Pole-Star* in the end of the *Tail*, and thoſe 2 that are in the fore part of the *Bear*, one of them upon his Back near the Neck, and the other upon his Side; and theſe two are call'd by our Mariners, *The Guards*. Theſe three Stars are of excellent uſe in Navigation, and well known by Seamen.

The next Conſtellation is *Draco*, or the *Dragon*, and hath ſundry Stars, which you may learn to know by the Rules following. The third is *Cepheus*; the fourth is *Caſſiopeia*; the fifth is *Urſa Major*, or the *Great Bear*; the ſixth *Auriga*; the ſeventh *Cygnus*.

And laſtly, there are twelve Lines drawn from the Pole, which are Meridians, and are of great uſe; as you may learn hereafter.

Here follow ſeveral Uſes of the Circles of the Nocturnal.

1. The Circle whereon the *Rundle* is fix'd, which is divided into 24 Hours, notes the 24 Hours of the Night and Day, and alſo the quarters of every Hour, and half of each quarter, which is but 7 Minutes and a half; ſo that you may work to half a quarter of an hour of Time by this Inſtrument, be it either Time given, or Time ſought for, as the Queſtion importeth.

2. The Uſe of the Months, and their Diviſion into Days, is either to give the Day of the Month ſought for, or by the Day of the Month given, to find another thing requir'd, as the Queſtion imports.

3. The Uſe of the Circle of Signs is to know the place of the Sun in the Ecliptick every day in the Year.

4. The Uſe of the Stars and their Conſtellations is twofold: 1. To learn to know thoſe Stars one from another, and from all

other Stars. And, 2. Knowing them, to make uſe of them, as the Queſtion ye are to reſolve requires.

And note this, That that Star which is in the Tail of the *Little Bear*, is neareſt the North-Pole; and as in the *Rundle* all the reſt of the Stars ſeem to move round this Star, ſo do they in the Heavens ſeem to move round it alſo: this being an exact Type or Figure of the Stars near the Pole.

5. The Uſe of the Meridian Lines which meet in the Pole is threefold: 1. For the more ocular Diſtinction of each Sign. 2. To ſhew the right Aſcenſion of any Star deſcrib'd in the *Rundle*. 3. For the finding the Declination of any Star on the *Rundle*. One of the Meridian Lines, *viz.* that which paſſes through the beginning of *ARIES*, is divided into Degrees of Declination. And, 4. To ſhew how to bring any Star to the Meridian of the *Nocturnal*, which is the Hour of 12 under the *Flower-de-luce*.

And becauſe we ſeldom ſee a Star juſt upon the Meridian, therefore do theſe Meridians alſo ſhew how to place the Star either ſhort or paſt the Meridian, which we could not elſe do well by gueſs.

Thus much I judged meet, not only for the uſe that theſe Definitions are of in the uſe of this Inſtrument, but becauſe they may ſatiſfy the deſire of ſome that are not verſed in

Mathematical Phraſes, and yet would willingly know the reaſon of ſuch things. I ſhall now ſhew you a few of the moſt practical Uſes of this Inſtrument, that they may be eaſily underſtood of thoſe that are not Mathematically diſciplined.

First then, *To learn to know the Stars deſcribed in the Rundle one from another, and from the reſt of the Stars that we ſee in the Heavens.*

In a Night when the Stars may be ſeen, look toward the North part of Heaven, and there you may take notice of Seven very bright Stars, lying in the ſame Form as ye ſee in the Image of the *Great Bear*; four lying in a Square, or like the four Wheels of a Waggon; and three, which you may imagine to be three Horſes following one another. The Form how they lie, you may ſee in the Rundle between the Signs *Virgo* and *Libra*: Theſe being well known, you may look what Star lies near any of them, and there you will find what Star it is. As for Example:

I ſee a Star lying juſt over a Star in the *Breat Bear's* Back: Looking in the Rundle, I find the Star to be in the end of the *Dragon's Tail*; and ſo you may learn to know them all one from the other, comparing the Stars ye ſee in the Heavens, to them that are in the Rundle: and tho you may ſee many Stars in the Heavens, yet theſe are the brighteſt, and of greateſt Magnitude amongſt them.

Another

Another way to know the Name of a Star, and to know it from others.

Firſt note a Star in the Heavens, that you ſee is upon, or near the Meridian; then look in the Nocturnal for the Day of the Month, and bring that Day to the Hour of the Night next the *Flower-de-luce*; then look what Star lieth between the *Flower-de-luce*, and the Pole in the Rundle; and if the Star in Heaven be lower than the Pole, the Star you find in the Nocturnal ſhall be the Star you ſaw in Heaven: But if the Star you ſaw in Heaven be above the Pole, then muſt you ſeek the Star between the Center and the South Point of the Nocturnal. But then if looking on the Rundle you find two Stars on the Meridian, note which is neareſt the Pole, and which fartheſt off, and ſo you may know each from other.

Example. Upon the firſt of *April*, at half an hour paſt nine at night, I ſee two bright Stars upon the Meridian, the one nearer me than the other: Then to know the Names of thoſe two Stars, and to know them from others, I bring the firſt of *April* to half an hour paſt nine near the *Flower-de-luce*; (which *Flower-de-luce* notes Midnight) and becauſe the Stars in Heaven are higher than the Pole, I look from the South Point of the Nocturnal's Limb towards the Center of the Nocturnal, and then ſee the Star neareſt me (as it lies in Heaven) to be in the Belly of the *Great Bear*, and that fartheſt from me, to be in the Back of the *Bear*; and then looking a little to the Eaſtward in Heaven, I ſee two more follow, and after them cometh three more: for theſe I look in the Rundle, and one of the two next to the two I found on the Meridian, is upon the *Great Bear's* Thigh, the other upon his Buttock: The firſt of the three following is in the Root of the Tail, the ſecond about the middle of the Tail, the third in the end of the Tail. And by this you may come to know all the Stars inſcribed in the Rundle.

How to find out the North Star from the reſt which you ſee in Heaven.

This Star is very bright, being one of the ſecond Magnitude, or Bigneſs.

The moſt exact and ſpeedy way is this:

Take your Quadrant, and as near as you can gueſs, look through the Sights of your Inſtrument into the North part of the Heavens ſo high as is the Latitude of your place, and it will ſoon ſhew you whereabout it is, for there is no Star ſo great near it; and when you have thus found it, be ſure you note it well how it lies from the other Stars, that you may know it again. Thus at *London*, the Latitude being 51 Degrees and a half, I lift up the Sights of the Quadrant till the Thred fall upon 51 Degrees and a half; then looking ſtill at that height, I look as near the North Point as I can gueſs, and there, or very near, is the Pole, or North Star: If you have a Magnetick-Needle, that will ſhew you the North Point of Heaven.

The next way to find the North Star is this, which is done without any Inſtrument.

Look into the North part of Heaven; note ſome Star that is a little above half the height of Heaven, from the lower part of the Heavens; and by diligent notice ſee whether in an hour's time, or more, you can ſee it remove from the place where you firſt ſaw it; if it be removed, that is not the Star: and ſo continuing, note the Star that lieth as before ſaid, half above the Horizon, and moves not, and that is the Pole-Star; and this Star will be the ſooner known, becauſe it is more remote from any bright Star than any near it.

The reaſon why this Star ſcarce moves, is, becauſe it is near the Pole, and the other Stars move round this; yet is not this Star without a Motion, for it moves round the true Pole, but the Eye can ſcarce perceive it to move at all.

An Example of this in a Night when the Stars may be ſeen:

I look up half way into Heaven, and a little higher, and as near North as I can; which I know by the building of a Church, whoſe Steeple ſtands always Weſt from the Church: and there I ſee a bright Star by it ſelf, and it ſtands ſo that I may juſt ſee it by the edge of a Houſe-wall; then I mark how, and where I ſtood, and go away, and come two, three, four, or five Hours after, and ſtand juſt in the place as I did before, and find that the Star is not remov'd out of that place; therefore by all tokens this muſt needs be the Pole-Star: but if I find the Star remov'd, I conclude that that is not the Star; but I try another, and another till I find it; taking this for my ſure ground, that it lieth full North from me, and that a little above half of the height of the Heaven or thereabout, in the Latitude of 51 Degrees.

The next thing is, how to know the Meridian in the Heavens.

Having found out the North Star, fix your Eye upon it, and imagine as near as you can a direct Line to be drawn from that Star to the place in the Heavens right over your Head, and that Line is the Meridian: and when you ſee any known Star come to this Line, then is that Star upon the Meridian; when a Star is not quite come to it, that Star is ſaid to want of its coming to the Meridian; when a Star is gone paſt this Line, 'tis paſt the Meridian; and this Line (for ſo we call it, becauſe all Men know not the meaning of an Arch) is an Arch of the true Meridian of that place; and whereas I ſay let this Line be drawn from the Pole-Star, it is for the eaſe of thoſe that are not verſed in Aſtronomy; tho the true Arch of the Meridian muſt be drawn from the true Pole, yet in the uſe of this Inſtrument it begets no ſenſible Error to draw this Line or Arch from the Pole Star.

To find the right Aſcenſion of any Star in the Rundle.

Count according to the Succeſſion of Signs the Number of Degrees comprehended between the beginning of *Aries*, and a Line drawn through the Center and your Star to the Circle of Signs, for that is the number of Degrees of right Aſcenſion your Star hath.

Example. I deſire to know the right Aſcenſion of the bright Star in the end of the *Great Bear*'s Tail. I lay a Thred from the Pole through that Star, and draw it into the Circle of Signs; then beginning to number at *Aries*, and proceeding to *Taurus*, *Gemini*, &c. I ſay, 30, 30, 30, is 90; 30, 30, 30, is 90 more, that is 180, which is the beginning of *Libra*, and almoſt 24 more, which is contain'd between the beginning of *Libra* and the Thred; that is almoſt 204 Degrees for the right Aſcenſion of the Star in the end of the *Great Bear's* Tail.

To find the Declination of any Star on the Nocturnal.

Pitch one foot of a pair of Compaſſes in the Center of the Nocturnal, and extend the other foot to the Star; then keeping the firſt foot in the Center, turn the other foot to the divided Meridian-Line, and ſo many Degrees as are contain'd between the two feet of the Compaſſes is the Complement of the Star's Declination, that is, ſo many Degrees the Star wants of 90. Thus the Declination of the aforeſaid Star in the end of the *Great Bear's* Tail, is found to be 15 Degrees and one quarter of a Degree.

The Day of the Month, and a Star on the Meridian being given, to find the Hour of the Night.

Bring the Star which you ſee upon the Meridian to the *Flower-de-luce*, and then look from the Day of the Month; and right againſt it you have the Hour of the Night given.

Example. Upon the firſt of *April* at Night, I ſee the Bright Star in the Rump of the *Great Bear's* Tail upon the Meridian, therefore I bring it to the *Flower-de-luce*, and looking upon the firſt Day of *April*, I find it a quarter of an Hour paſt 11.

Next, *The Hour of the Night, with a Star upon the Meridian given, to find the Day of the Month.*

Bring the Star to the *Flower-de-luce*, and right againſt the Hour of the Night is the Day of the Month. This needs no Example.

The Day of the Month with the Hour given, to know what Star is upon the Meridian.

Bring the time of the Day, and the Day

of the Month together; and what Stars you find upon a right Line imagin'd to paſs between the North and South Points of the Nocturnal, thoſe are upon the Meridian.

The Day of the Month given, to find the Sign and Degree the Sun is in.

Seek the Day of the Month in the Rundle of the Nocturnal, and againſt it in the Circle of Signs you will find the Sign and Degree the Sun is in.

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